

I claim:

1. A power cogeneration partially-open oxy-fuel combustion cycle method and system having recirculated gaseous thermal fluid and apparatus devices for conversion of hydrocarbon fuel heat-value energy into mechanical energy power and transferable residual exhaust energy for useful purposes, comprising:

(a) a partially-open oxy-fuel combustion cycle method containing a continuously recirculated superheated gaseous thermal fluid;

(b) one or more combustion chamber apparatus assembly or subassembly device wherein temperature controlled oxy-fuel combustion takes place;

(c) one or more integral power engine unit apparatus assembly device wherein hydrocarbon fuel heat-value energy is converted into mechanical power energy and exhaust gas residual energy for useful heating of other gaseous or liquid fluids;

(d) an integral power unit apparatus device therein containing, but not limited to, a recycle gas compressor apparatus assembly or subassembly device, one or more oxy-fuel combustion chamber assembly or subassembly device, and a hot gas expansion power extraction assembly or subassembly device;

(d) two or more alternative power engine unit apparatus assemblies or subassembly devices collectively performing identical energy conversion step functions as those performed within an integral power engine unit apparatus assembly;

(e) one or more heat exchanger assembly devices, wherein

1. a quantity of heat energy is extracted from one cited cycle recirculated gaseous thermal fluid stream and transferred to either one or more other cited cycle recirculated gaseous thermal fluid stream,

2. a quantity of heat energy is extracted from one cited cycle recirculated gaseous thermal fluid stream and transferred to one or more other supply/return fluid streams originating from outside the partially-open cycle and cogeneration system, and

3. the heat exchanger assembly contains one or more sections, each section therein having fluid heat transfer coils;

(f) a valve apparatus device for controlling individual flow streams of fuel and a predominant oxygen mixture gas stream entering into the cited partially-open cycle and power cogeneration system from remote supply sources;

(g) the power cogeneration system therein having control means for controlling an excess flow stream portion of the partially-open cycle's recirculated gaseous thermal fluid stream, the said excess controlled stream portion thereafter exhausted from within the cited cycle and vented to atmosphere;

(h) the power cogeneration system having conduit means therein providing for fluid flow communication between individual apparatus devices, and between apparatus devices within the system and other supply/return fluid streams originating from outside the partially-open cycle's boundary limits;

(i) an alternative system addition of apparatus devices therein independently supplementing the production flow of oxy-fuel combustion exhaust gas flows within a conduit manifold having communication to one or more exhaust waste heat recovery exchanger device; and

(j) a power cogeneration system PLC control panel device having monitoring and control communication with instrumentation and fluid flow control devices mounted to and/or positioned within cited conduits and apparatus devices, all said devices

complying with industry and governmental codes/ standards for safe operation and acceptable operating reliability.

2. The partially-open oxy-fuel combustion cycle method's recirculated superheated gaseous thermal fluid of claim 1 further comprising:

(a) a gaseous fluid whose molecular gas composition remains unchanged throughout the cycle with a given employed fuel;

(b) a gaseous fluid continuing throughout the cycle in a superheated temperature gaseous state;

(c) a gaseous fluid composed of highly predominate binary carbon dioxide and binary water vapor exhaust gases; and

(d) a gaseous fluid of highly superheated temperature having the thermal characteristic of adsorbing or releasing approximately 40% more Btus of heat energy per pound of gas per degree Fahrenheit change in gas temperature, as compared to conventional air/fuel combustion chamber exhaust gases.

3. The oxy-fuel combustion cycle method and apparatus devices of claim 1 further comprising:

(a) one or more oxy-fuel combustion chamber devices wherein temperature controlled combustion takes place, said combustion and generated heat of combustion dispersal being highly accelerated, thereby achieving an extremely rapid preset uniform equilibrium temperature of gases within the cited oxy-fuel combustion chamber;

(b) one or more oxy-fuel combustion chamber devices wherein temperature controlled combustion takes place, said combustion comprising a primary combustion flame zone wherein hydrocarbon fuel and oxygen chemical reactions produce

extraordinary high superheated water vapor and carbon dioxide as products of said combustion;

(c) one or more oxy-fuel combustion chamber devices wherein a mass of generated extraordinary high superheated water vapor and carbon dioxide combustion gaseous products radiantly emit their individual gas heat energy to other like gases therein adsorbing the cited radiated heat energy at the speed of light velocity of 186,000 miles per second;

(d) an ultra-low level of resultant generated oxy-fuel combustion exhaust emissions of nitrogen oxide and carbon monoxide gases achieved from a control of preset combustion chamber primary zone equilibrium temperature, said temperature being below that in which the cited exhaust emissions are produced from disassociation chemical reactions;

(e) the cited partially-open cycle containing a recirculated superheated gaseous thermal fluid, said gaseous fluid then re-pressurized or compressed by a cited recycle compressor and thereafter increased in superheat temperature to establish a cycle gas stream then referred to as a "working motive fluid" gas stream;

(f) the cycle's working motive fluid gas having mass flows, gas thermal characteristics, and highly superheated temperatures for the highly efficient conversion of thermal heat energy into mechanical power, and useful transfer of residual thermal energy to other fluid streams;

(g) an oxy-fuel combustion chamber having partial premix assembly means of co-mingling and/or homogeneously blending introduced controlled flow streams of working motive fluid gas, fuel, and predominant oxygen gas mixture for a resulting controlled ignition/combustion temperature of said fuel;

(h) an introduced individual controlled fluid stream of fuel, and of separate predominant oxygen mixture stream, into the partially-open cycle through conduit means originating from remote supply sources exterior to the recited cycle boundary limits;

(i) a mass mixture of pressurized working motive fluid gases introduced into the cited oxy-fuel combustion chamber and combined with fuel combustion product gases, the combined gases thereafter expanded through a apparatus device means to convert the said gases' thermal energy into mechanical power energy; and

(j) a steady-state partial-open thermal fluid energy cycle method wherein controlled conduit mass flows of excess recirculated exhaust gases, said gases exhaust-vented from the cited cycle to atmosphere, are in mass flow equilibrium with the combined mass flows of fuel and predominant oxygen mixture entering into cited cycle.

4. The cycle's recirculated superheated gaseous thermal fluid method of claim 1 further comprising:

(a) a method gaseous molecular mixture composed of highly predominate binary carbon dioxide and binary water vapor gases having a carbon dioxide Mol % to water vapor Mol % ratio therein being identical to the carbon dioxide Mol % to water vapor Mol % ratio of these products of combustion as generated by the combustion of a given hydrocarbon fuel; and

(b) a method gaseous molecular mixture predominately consisting of carbon dioxide and water vapor, with respectively lesser descending Mol percents of argon, excess combustion oxygen, nitrogen, and rare atmospheric gases completing the total molecular composition of the thermal fluid's gaseous molecular composition.

5. The integral power engine unit apparatus assembly device of claim 1 further comprising:

(a) An exhaust gas recycle compressor assembly or subassembly device connected by shaft means to a later described hot gas expansion power extraction assembly or subassembly device;

(b) One or more oxy-fuel combustion chamber/combustor assembly or subassembly device;

(c) A hot gas expansion power extraction assembly or subassembly device, therein converting an oxy-fuel combustion chamber assembly's discharged working motive fluid with gaseous thermal and pressure expansion energy into mechanical shaft output energy; and

(d) an emitted flow of reduced temperature working motive fluid exhaust gases, therein discharged into an exhaust conduit manifold connected to a later described downstream-positioned waste heat recovery exchanger means.

6. The two or more alternative power unit apparatus assemblies of claim 1 further comprising:

(a) an integral motor or steam turbine driven exhaust gas recycle compressor apparatus assembly, therein replacing the cycle function performed by the exhaust gas recycle compressor assembly or subassembly device within the fore-cited integral power engine unit apparatus assembly device; and

(b) an integral apparatus assembly containing an oxy-fuel combustion chamber subassembly connected to a hot gas expansion power extraction assembly or subassembly.

7. The heat exchanger assembly devices of claim 1 further comprising:

(a) a power engine unit exhaust waste heat recovery unit (WHRU) exchanger assembly conduit-positioned downstream of a power engine unit for transfer of power engine unit exhaust gas residual heat energy to fluid coils contained within two parallel exchanger sections contained within the WHRU exchanger assembly;

(b) a power engine unit 'first' exhaust waste heat recovery stream generator (WHRSG) exchanger assembly, or waste heat recovery process fluid (WHRPF) exchanger assembly, hereafter referred to as the WHRSG/WHRPF exchanger assembly positioned in parallel with the WHRU exchanger assembly and having conduit communication to a power engine unit's exhaust manifold;

(c) a power engine unit 'first' WHRSG/WHRPF exchanger assembly having conduit communication with the power engine unit exhaust manifold for the transfer of exhaust gas residual heat energy to fluid coils contained within the WHRSG/ WHRPF exchanger assembly;

(d) a power engine unit 'second' exhaust gas WHRSG/WHRPF heat exchanger assembly comprising

1. a heat exchanger assembly having a upstream common manifold conduit communication with the parallel connected WHRU and 'first' WHRSG/WHRPF exchanger assemblies,

2. a heat exchanger assembly discharging slightly superheated recirculated exhaust gas into a downstream exhaust gas distribution manifold means, and

3. a heat exchanger assembly transferring exhaust gas residual heat energy to hot water/steam coils or process fluid coils contained within the exchanger assembly;

(e) an air-cooled exchanger through which a small controlled stream flow portion

of recited primary recycle gases is cooled and conduit-connected to one or more fore-cited oxy-fuel combustion chamber assembly.

8. One or more combustion chamber apparatus assembly or subassembly device of claim 1 further comprising:

(a) a partial premix subassembly therein receiving controlled communicating flow streams of

1. a gaseous or liquid hydrocarbon fuel from a connected remote source,
2. a gaseous mixture of predominant oxygen gases from a connected remote source, and

3. a low gas flow stream of primary re-pressurized and slightly superheated recycle gas from a connected fore-cited air-cooled heat exchanger;

(b) an internal primary combustion zone within each oxy-fuel combustion chamber assembly therein receiving a communicating second flow stream of working motive fluid from the fore-cited WHRU heat exchanger;

(c) an internal tertiary blending zone within each oxy-fuel combustion chamber assembly, therein receiving a communicating first flow stream of working motive fluid from the fore-cited WHRU heat exchanger.

9. An alternative cycle method and apparatus devices for independently supplementing the production flow of oxy-fuel combustion exhaust flows of claim 1 further comprising:

(a) one or more exhaust recycle gas blower and common oxy-fuel fired combustion burner assembly being parallel gas flow-positioned within the cycle to the power engine unit apparatus;

(b) an inlet to each gas blower being conduit-connected with a supply of 'exhaust recycle gas' withdrawn from the cycle system's exhaust gas distribution manifold;



(c) one or more gas blowers, where in the case of two parallel-positioned gas blowers, individual blower controlled gas discharge streams have conduit-connectivity respectively with a partial premix subassembly and a tertiary blending zone within a oxy-fuel fired combustion burner assembly;

(d) a controlled conduit flow stream of supplied predominant oxygen mixture gas and a controlled conduit flow stream of supplied fuel, wherein each said stream is conduit end--connected with the oxy-fuel fired combustion burner assembly's partial premix subassembly;

(e) the oxy-fuel fired combustion burner assembly having an exhaust gas flow conduit connectivity to, and co-mingled with, the power engine unit exhaust gases contained within an exhaust conduit manifold having connectivity to the downstream positioned fore-cited WHRU and WHRSG/WHRPF heat exchanger assembly devices.

10. a hot gas expansion power extraction assembly or subassembly device means of claim 5, wherein a compressed and highly superheated working motive fluid is expanded to a lesser pressure and temperature thereby creating mechanical energy, the hot gas expansion power extraction device configured as:

(a) a conventional rotating hot gas power turbine assembly or subassembly device having two or more power turbine wheel expander stages;

(b) a conventional rotating hot gas power turbine assembly or subassembly device having one or more first-positioned power turbine wheel expander stages with shaft direct-connected to a recycle gas compressor assembly;

(c) a conventional rotating hot gas power turbine assembly or subassembly device having one or more last-positioned power turbine wheel expander stages with direct-connected output mechanical drive shaft; and

(d) a less conventional rotating hot gas power turbine apparatus assembly or subassembly device having one or more power turbine wheel expander stages with direct-connected output mechanical drive shaft.

11. one or more integral power engine unit apparatus assembly device of claim 1 having a configuration comprising but not limited to either one of:

(a) a presented and described modified rotating gas turbine apparatus assembly;

(b) a presented and alternative described two or more combined modified conventional rotating apparatus assemblies in combination with a oxy-fuel combustion chamber assembly device;

(c) a modified reciprocating type engine apparatus assembly device having two or more subassembly devices therein including one or more reciprocating piston subassembly devices having articulating communication means with a rotating mechanical power output crankshaft means.

12. A conduit means of claim 1 providing for fluid flow communication between individual apparatus devices within the cited cycle, and further providing for fluid flow communication between apparatus devices within the cited cycle and cycle-remote fluid connection points of fluid supply and/or fluid return, said conduit means further comprising:

(a) Three or more selected conduit means therein containing fluid flow control valves or pressure control valves, and sensor/transmitter instrumentation devices having electronic signal communication with a power cogeneration system PLC type control panel;

(b) All conduits with interior flows of cycle gaseous thermal fluid therein having exterior conduit-connected insulation means for purposes of minimizing heat losses from the recited partially-open cycle, and for purposes of facility personnel safety; and

(c) sensor/transmitter instrumentation devices having electronic signal communication with a power cogeneration system PLC type control panel.

13. The recited sensor/transmitter instrumentation devices of claim 12 further comprising but not limited to:

(a) the cycle gaseous thermal fluid streams' temperature and pressure sensing devices as required for cycle control purposes,

(b) a fuel supply stream's pressure and temperature sensing device,

(c) an oxy-fuel combustion chamber assembly's primary combustion zone and tertiary zone discharge temperature sensing devices,

(d) the cycle gaseous thermal fluid streams' mass flow calculating devices as required for cycle and cogeneration method control purposes,

(e) a cycle gaseous thermal fluid's recirculated exhaust stream oxygen content sensing / calculating device, and

(f) a cycle oxygen supply source stream's pure oxygen content sensing / calculating device.

14. A power cogeneration system PLC type control panel of claim 12 further comprising but not limited to:

(a) the means of receiving electronic input data signals from sensor/transmitter devices, said signals having relevance to monitoring for safe operating conditions and the control of conduit fluid flows as required to meet cycle produced power output demands and demands for transferred waste heat to other cycle-exterior fluid streams;

(b) the alternative means of receiving electronic input data signals from a manufacturer's standard power engine unit PLC control panel, the said input data signals being power cogeneration PLC control panel integrated as necessary for the control and safe operation of the oxy-fuel cycle and complete power cogeneration system;

(c) the cited power cogeneration PLC control panel means of transmitting PLC computed electronic output data signals to the appropriate fluid flow control valves in response to cited input signals, a response output signal change including but not limited to

1. a change in output signal to the valve that control the flow of predominant oxygen mixture into the cited cycle, following a signal change from the oxygen sensor positioned in the cycle's recirculated exhaust manifold,

2. a change in output signal to the valve that controls the flow of fuel into the cycle, following a change in signal from the temperature sensor in the oxy-fuel combustion chambers' primary zone, and

3. a change in separate output signals to the separate valves that control the flows of fuel and predominant oxygen mixture into the cited cycle, and a change in signal to a recycle gas compressor's output flow control means, following a change of a facility's input signal corresponding to a change in facility power demand on the power cogeneration system.